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RESEARCH DEPARTMENT

REPORT

**CEEFAX:
interference with television from
data signals transmitted in
the field—blanking period**

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**CEEFAX: INTERFERENCE WITH TELEVISION FROM DATA SIGNALS
TRANSMITTED IN THE FIELD-BLANKING PERIOD**
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Summary

This Report presents the results of engineering broadcast tests which were carried out during the early part of 1973 to examine the suitability of certain lines in the television field-blanking interval for the transmission of CEEFAX digital data signals. It was concluded that lines 17 and 18 were preferred for this purpose.*

* In this Report, reference to lines 17 and 18 will be understood to include lines 330 and 331 in the odd field, unless otherwise stated; similarly reference to lines 13 and 14 will be taken to include lines 326 and 327.

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Section	Title	Page
Summary		Title Page
1. Introduction		1
2. Description of the data and the causes of interference		1
3. The broadcast tests		1
4. Summary of results		2
4.1. Results of the first set of tests		2
4.2. Results of the second set of tests		3
4.3. Results of the third set of tests		4
5. Conclusions and recommendations		4
6. Reference		4



CEEFAX: INTERFERENCE WITH TELEVISION FROM DATA SIGNALS TRANSMITTED IN THE FIELD-BLANKING PERIOD

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1. Introduction

The development of the experimental CEEFAX data broadcasting system, in which data is transmitted on two successive lines in the television field-blanking interval has already prompted an investigation into the possible forms of interference caused by such data. This previous work¹ had suggested that the data could probably be transmitted on lines 13 and 14 without causing interference, or, failing this, on lines 17 and 18. These latter lines were the second choice as they are already allocated for the international I.T.S.* and would not, therefore, be available for the international exchange of data. The results of this previous work were, however, somewhat tentative and needed to be substantiated by carrying out broadcast tests.

It was decided to transmit a special test signal (using a previously prepared video tape recording) from all the BBC-1 transmitters in the country (625 and 405 lines) when there were no scheduled programmes, for example, after closedown at night.

Roughly 600 Questionnaires were distributed throughout the country; some were distributed within the BBC, for use by staff on duty at switching centres and transmitters or off-duty at home, and some were distributed to the television receiver industry through BREMA.**

2. Description of the data and the causes of interference

Because, at the time of the tests, a CEEFAX data signal was not yet available it had to be simulated. This was achieved by clocking a pseudo-random sequence generator at approximately 4.5 MHz (at an integer multiple of line frequency) and filtering the output pulse train so as to provide raised-cosine pulses; this simulated data was then switched to whichever television lines were appropriate for the particular test. The sequence generator was arranged to provide an approximately random sequence of data pulses along the television line, with a constant mean d.c. level when considered over one cycle of the pseudo-random generator. It was known that the mean d.c. level of CEEFAX data would be subject to fluctuation, being dependent on the message content and, to allow for this, the mean d.c. level was deliberately varied in some of the tests by cyclically changing the level of the data-pulses by 6 dB at a rate of approximately 5 Hz.

From previous experience, it was considered that data might cause any of five distinct forms of interference; these are summarised below:

1. Certain receivers are susceptible to 'buzz-on-sound', even on normal transmissions. The buzz is sometimes due to the effects of vestigial sideband reception and, in such cases, is a function of the amplitudes of components of the video signal with frequencies near 3 MHz. It was considered that data might also cause interference in this way. Clearly the level of the data would be important in this case.
2. Receivers from time to time are used with vertical underscanning and/or displacement of the picture downwards. Under these circumstances the data may be visible in the gap between the active picture and the top of the screen.
3. On certain receivers, with slow vertical flyback and inadequate* vertical flyback suppression, the data can appear in the position occupied by certain of the flyback lines, thus interfering with the active picture. The position of the data is important since data carried by earlier television lines (i.e. nearer the field synchronising signal) will stand a greater chance of occurring during the vertical flyback of the receiver.
4. In the case where the mean d.c. level is fluctuating, a.g.c. effects might cause flickering of the picture background; further the flare due to the data illuminating that part of the phosphor normally masked off at the top of the screen might be visible at the top of the picture.
5. It was thought that certain colour-killer circuits might respond to the data signal and, if data were present, fail to disable the receiver chrominance-circuits during monochrome transmissions. This could result in cross-colour on monochrome transmissions.

3. The broadcast tests

Three sets of broadcast tests were transmitted. The first was concerned with the transmission of data on lines 13 and 14. After analysing the results of these tests, a second set was carried out which included tests on lines 17 and 18 as well as on 13 and 14. Finally, a third set was performed to confirm the choice of lines 17 and 18 as the data-carrying lines.

In order to provide a choice of viewing time, each set of tests was repeated a day or so after the first transmission. One type of questionnaire was used for all the tests and is illustrated in Fig. 1, occupying the last four pages of this Report. The participants were asked to state whether

* Insertion Test Signal.

** British Radio Equipment Manufacturers Association.

* Vertical flyback suppression may be adequate for reception of video signals without added data, but insufficient to suppress additional data.

they could detect any of the five main impairments described. The picture sources used in all the sessions were Test Card 'F' and 'Sawtooth'. Sawtooth was included since the lack of picture detail and gradual left-to-right transition from black to white make it easy to detect data on the vertical flyback lines. In each session there were four tests, and in each test both Test Card and Sawtooth were shown twice. The level and position of the data was varied between the tests, but the observers were given no details of these changes.

In addition, it will be seen that there was room on the questionnaire for comments about any other impairments which might have been seen; BBC staff at monitoring points and transmitters were asked to record any abnormalities in the operation of their equipment.

Although primarily intended for 625-line viewers, those watching 405-line pictures were invited to participate in case the operation of 625/405 line-store converters was affected by the presence of the data. To this end the staff at 405-line transmitters were also asked to comment on any abnormal behaviour of their equipment.

4. Summary of results

The results of the tests are summarised in Tables 1, 2 and 3. In each case the percentage of 625-line observers recording the presence of a particular impairment is given, together with details of the data signal transmitted in each test.

4.1. Results of the first set of tests

Table 1 summarises the tests carried out using data only on lines 13 and 14. The levels of the data signal are expressed in dB relative to white level (0.7V). Data levels of -3 dB, no data, -9 dB, and data alternating at 5 Hz between -3 dB and -9 dB were used in tests 1 to 4, respectively. The following deductions can be made from the results:

Buzz-on-Sound

A large proportion of viewers recorded this impairment, even in the absence of data. It must be concluded that the buzz-on-sound was mainly due to the nature of the picture information, and not due to the presence of data.

Data above the active picture

This was recorded by a substantial number of observers, up to 18% with data at -3 dB, and up to 16% with data at -9 dB. Some 2% of observers recorded data even when none was being transmitted; it must be assumed that this was caused by some confusion with the ITS. The result is an indication of the proportion of viewers who operate their receivers with less than full vertical scan, or with the picture displaced vertically downwards.

Data during field-flyback

This effect was seen by an unexpectedly and disturbingly high number of observers (up to 7% with data at -3 dB and up to 5% with data at -9 dB). Since there is nothing but the viewer can do to remove this effect, if seen, it represents a very serious impairment.

Background flickering

There was no evidence of background flickering due to changes in the mean d.c. level of the data, although later examination showed that some fluctuation in background level was present on the original video tape recording, and this is no doubt what the observers could see.

Cross-colour

No evidence was found of cross-colour effects due to the presence of data.

TABLE 1

Results of the first set of tests, based upon 257 replies. Data on lines 13(326) and 14(327)

Nature of Impairment	Percentage of Observers Recording the Impairment							
	Test 1 Data at -3 dB		Test 2 No Data		Test 3 Data at -9 dB		Test 4 Data at (-3 ↔ -9) dB	
	Test Card	Sawtooth	Test Card	Sawtooth	Test Card	Sawtooth	Test Card	Sawtooth
Buzz-on-sound	28	7	30	7	30	6	32	7
Data above active picture	18	17	2	1	16	14	18	17
Data during field flyback	4	7	0	2	2	5	5	8
Background flickering	6	8	5	5	7	8	7	7
Cross-colour	9	½	11	½	11	½	10	1

TABLE 2
Results of the second set of tests, based upon 46 replies

Nature of Impairment	Percentage of Observers Recording the Impairment							
	Test 1 Lines 13, 14 -3 dB		Test 2 Lines 17, 18 -3 dB		Test 3 No Data		Test 4 Lines 17, 18 -9 dB	
	Test Card	Sawtooth	Test Card	Sawtooth	Test Card	Sawtooth	Test Card	Sawtooth
Buzz-on-sound	9	4	9	7	7	2	7	4
Data above active picture	33	30	37	39	2	2	35	35
Data during field-flyback	22	28	0	0	0	0	0	0
Background flickering	11	2	11	2	11	4	11	2
Cross-colour	15	4	13	4	11	4	11	2

The most important conclusion to be drawn from these tests is that an appreciable percentage of receivers had vertical-flyback times which embraced lines 13 and 14 and this, combined with poor field-flyback suppression, caused data to be visible as interference within the active picture. Consideration, therefore, had to be given to using lines 17 and 18 instead. This led to the second set of tests in which a comparison took place between the effects of data on lines 13 and 14 and lines 17 and 18. The observers who recorded having observed data during field-flyback in the first set of tests were particularly requested to participate.

4.2. Results of the second set of tests

Table 2 shows the results. Test No. 1 used data on lines 13 and 14 at -3 dB, whilst Tests 2-4 used data on lines 17 and 18 at -3 dB, no data and -9 dB respectively. The results can be summarised as follows:-

Buzz-on-Sound

As before, there is no significant evidence that data gave rise to this impairment; that which was observed varied significantly with the picture information.

Data above the active picture

This was seen by up to 33% of the observers with the data on lines 13 and 14 and up to 39% of the observers when the data was on lines 17 and 18. This is to be expected in view of the greater proximity of the data to the active picture in the latter case.

Data during field-flyback

No interference was visible when the data was transmitted on lines 17 and 18.

TABLE 3

Results of the third set of tests, based upon 179 replies. Data on lines 17(326) and 18(327)

Nature of Impairment	Percentage of Observers Recording the Impairment							
	Test 1 Data level -3 dB		Test 2 Data level -12 dB		Test 3 Data level -9 dB		Test 4 No Data	
	Test Card	Sawtooth	Test Card	Sawtooth	Test Card	Sawtooth	Test Card	Sawtooth
Buzz-on-sound	24	6	25	7	24	7	23	7
Data above active picture	21	20	11	12	15	13	1	1
Data during field-flyback	0	0	0	0	0	0	0	0
Background flickering	5	4	6	6	6	7	6	7
Cross-colour	8	½	8	½	8	0	8	0

Background flickering

Since fluctuating data levels were not transmitted in this session, this form of interference, attributable to data, would not be expected.

Cross-colour

High-level data (i.e. at -3 dB) on either pair of lines appeared to score slightly higher in this series of tests. Some cross-colour due to data might possibly be indicated.

This second set of tests, which was not intended to be the final one, mainly involved BBC staff at transmitters, and those viewers who had recorded having seen data during field-flyback in the first set of tests. The results are, therefore, not quantitatively significant, but indicate that lines 17 and 18 might be acceptable. The third set of tests was held to confirm this.

4.3. Results of the third set of tests

Table 3 shows the results obtained. Tests 1 to 4 contained data at -3 dB, -12 dB, -9 dB and no data, respectively, all the data being located on lines 17 and 18.

Buzz-on-Sound

Again there was no evidence of buzz-on-sound due to data.

Data above active picture

The data above the active picture was seen by up to 21% of observers with a data level of -3 dB, but this dropped to 11% when the level was reduced to -12 dB. Clearly there is some advantage to be gained by reducing the data level.

Data during field-flyback

No observers reported the presence of this form of interference.

Background flickering

Fluctuating data levels were not transmitted in this series of tests.

Cross-colour

No significant cross-colour effects attributable to data were recorded.

5. Conclusions and recommendations

The most serious form of interference caused by data is its appearance during field-flyback; the viewer has no means of removing this impairment if it is present on his receiver (short of having it modified). Lines 13 and 14 have to be judged unusable for this reason. The use of lines 17 and 18, however, gave no evidence of this impairment and it was concluded that experimental CEEFAX transmissions could take place with data located on these lines.

With regard to the other forms of interference, it remains to be seen whether data signals visible above the active picture on underscanned receivers prove to be irritating to some viewers; there is at least a remedy* if this is the case.

The results in the second set of tests hinted that data might be causing non-operation of some colour-killers; however, the effect was not seen the first and third sets of tests where many more observers were involved. It is suspected that the effects recorded in the second set of tests could have been due to mistakes by some observers.

No impairments attributable to the data were ever noticed by the 405-line viewers or staff at 405-line transmitters, so it can be assumed that the operation of 625-to-405 line store converters was unaffected.

It is therefore recommended that experimental CEEFAX data be transmitted on lines 17 and 18 at a level within the range -3 dB to -9 dB relative to 0.7V (white level).

6. Reference

1. LE COUTEUR, G.M. 1973. Interference due to data transmitted after the television field synchronising signal. BBC Research Department Report No. 1973/12.

* Correct adjustment of the vertical scanning. This adjustment might have to be made by a service engineer if the control was inaccessible to the viewer.

**BBC Research Department Engineering Test
QUESTIONNAIRE**

SUPPLEMENTARY INFORMATION

To be supplied by BBC staff at monitoring points, transmitters, etc. in the television network.

1. Was the operation of your 625-line equipment normal during all the tests? If not please give details below.

1. Was the operation of your 625-line equipment normal during all the tests? If not please give details below.

(You are asked to read these notes carefully before participating in the tests)

The object of these tests is to verify the suitability of certain lines in the television field-blanking period for the simultaneous transmission of data signals.

There will be four tests in all and they are intended for 625-line viewers. However, if you are able to view on 405-lines your observations will be useful.

Each test will be announced on the sound channel and all tests will carry the same picture sequence, consisting of 30 seconds of a black-and-white test card followed by 30 seconds of 'Sawtooth'; this will be repeated making two minutes in all for each test.

You are asked to observe the pictures and listen to the sound in order to assess whether any interference is being caused by the transmission of simulated data signals. These data signals are unlikely to cause impairment except on a few receivers. The natures of possible impairments can be anticipated, however, and are set out below for your guidance.

(1) 'Buzz-on-sound'
(2) The appearance of the data signal just above the active picture area; the data might have a 'scintillating' (noise-like) appearance.
(3) The appearance of the data signal in the position occupied by certain of the field flyback lines, thus interfering with the active picture. This might be more noticeable when Sawtooth is transmitted. The data, if seen, will be visible as a noise-like signal.
(4) Flickering of the picture background (Please state whether the effect is visible uniformly over the picture or restricted to the top, middle, or bottom).
(5) (This aspect relates to colour receivers and test card only) Cross-colour on certain areas of the black-and-white test card, notably in the frequency gratings (colour receivers should be set up normally).
(6) Any other impairments not described in (1) to (5) above.



BBC Research Department Engineering Test QUESTIONNAIRE

PLEASE ENTER THE FOLLOWING DETAILS:

DATE
 LOCATION OF RECEIVER (NEAREST TOWN)
 625-LINE UHF CHANNEL NUMBER
 405-LINE VHF CHANNEL NUMBER

TYPE OF TELEVISION RECEIVER

MANUFACTURER MODEL NUMBER

COLOUR
 MONOCHROME
 DUAL STANDARD Please tick
 SINGLE STANDARD 625
 SINGLE STANDARD 405
 BBC PICTURE MONITOR

SUBJECTIVE TESTS *(Please answer 'YES' or 'NO' to the following questions by placing a TICK in the appropriate box)*

CAN YOU DETECT ANY OF THE IMPAIRMENTS IN THE LIST BELOW WITH EITHER TEST CARD OR 'SAWTOOTH' PICTURES?	TEST No. 1					TEST No. 2					TEST No. 3					TEST No. 4					
	TEST CARD		SAWTOOTH		TEST CARD		SAWTOOTH		TEST CARD		SAWTOOTH		TEST CARD		SAWTOOTH		TEST CARD		SAWTOOTH		
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
1. Buzz-on-sound	<input type="checkbox"/>																				
2. Data above active picture	<input type="checkbox"/>																				
3. Data during field flyback	<input type="checkbox"/>																				
4. Background flickering	<input type="checkbox"/>																				
5. Cross colour (on test card)	<input type="checkbox"/>																				

6. Any other impairments or remarks

PLEASE SEND THE COMPLETED QUESTIONNAIRE TO:

MR. G.M. LE COUEUR,
 BBC RESEARCH DEPARTMENT,
 KINGSWOOD WARREN,
 TADWORTH,
 SURREY.

MAY WE CONTACT YOU IF NECESSARY?

NAME
 TELEPHONE NO.:

